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ABSTRACT

This paper attempts to show the relationship between variable rules and more widely used psycholinguistic constructs such as amalgams and schemas, and to point out how variationists' methods can be useful in the study of language acquisition. The traditional rule, the rule for forming the past tense of regular verbs in English, is discussed as it relates to language acquisition in children. It is proposed that children go through three stages in the learning of the regular past tense: (1) the past tense of the words, or amalgams, are learned by rote; (2) the amalgams are associated by means of a schema; and (3) a categorical rule is constructed. The stages, proposed by Bybee and Slobin, identify schema as the missing link between amalgams and categorical rules. In a language acquisition study completed within the variationist framework, a pattern of language acquisition in subject-verb inversion of Wh-questions was isolated and three similar stages were followed, including: (1) formulaic patterns; (2) a variable rule; and (3) a categorical rule. The radial category hypothesis is proposed to satisfy the assertion that variation in child language development can be a prototype effect resulting from the prototype nature of a partially constructed grammatical category. (DJD)

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THE ROLE OF VARIABLE RULES IN LANGUAGE ACQUISITION

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Language acquisition scholars have been discouraged about using transformational-generative rules to model language acquisition. On the one hand, these scholars agree that child language and interlanguage exhibit patterns that arise from the kind of systematic, internal representation that T-G rules are meant to describe; but on the other hand, T-G rules don't seem to fit the kinds of patterns that have been observed. For example, in his study of Spanish speakers acquiring English, John Schumann (1978:9) remarked:

> We had orginally thought linguistic rules could be written for the negative and interrogative [structures]; however, this approach turned out to be unworkable due to the fact that our subjects' speech was constantly developing and contained a good deal of variation.... [Instead] the results were displayed in graphs .... Such analyses look much more like psychological data than linguistic data, but it has become evident that relative frequencies are more effective in capturing the dynamic nature of language acquisition than are traditional linguistic rules.

But unfortunately, graphs which display the relative frequencies of linguistic forms do not satisfy the original need to write linguistic rules, which was to make a psychologically valid statement about the mental representation of a linguistic system.

As sociolinguists know, adult, native speaker speech is variable; however, this speech does contain many invariant patterns which can be modeled by traditional, categorical, T-G style rules, such as the rule for the regular past tense or the rule for subject-verb inversion in WH questions. But, in the speech of language learners even these rules are not categorical. Thus, a way of modeling variation is needed even more in studies of language acquisition than in studies of adult native speaker speech. This point was made fourteen years ago by

Roger Brown (1973:388), who said, "If we were to write explicit rules capturing all the 'knowledge' of grammatical morphemes manifest in the child's use of these morphemes... these rules would have to be variable rules." Despite this early statement by the dean of language acquisition scholars, few psycholinguists have adopted the variation theory framework. Perhaps one reason for this reluctance is that it has been unclear what the relationship is between variation theory and language acquisition theory, and in particular how variable rules fit into the managerie of mentalistic constructs that psycholinguists use. In this paper I hope to show the relationship between variable rules and more widely used psycholinguistic constructs such as amalgams and schemas, and to point out how variationists' methods can be useful in the study of language acquisition.

We begin by looking at a much studied traditional rule -- the rule for forming the past tense of regular verbs, which I have represented in (1).

(1)

PAST $\rightarrow$ a. /Id/ / [-sonorant] [+alveolar] [-palatal] # ____

b. D / [α voice] [α voice] # ____

Rule (1) says that if the final segment of the base form of a regular verb is an alveolar stop, the past tense morpheme is realized as /Id/; if the final segment is some other sound, the past tense morpheme is realized as an alveolar stop which agrees in voicing with that final segment.

Bybee and Slobin (1982) in an experimental study of the acquisition of the past tense by children, found that the regular past tense rule is applied relatively late in environment a., that is, to verbs whose base form ends in an alveolar stop. Thus, children tend to apply the rule to verbs like jump and play before they apply it to verbs like need. To explain this fact, Bybee and Slobin suggest that rule learning contains the three stages shown in (2):

(2) a. The past tense forms of individual words, or amalgams, are learned by rote. Thus, when children first produce correct forms like jumped and played, these forms are unrelated.

b. The amalgams are associated by means of a schema.

c. A categorical rule is constructed.

The fact that early linguistic forms are learned as amalgams is well documented in first language acquisition by Peters (1977), and in second language acquisition by Wong-Fillmore (1979) and Hakuta (1974). The psychological validity of a productive rule like (1) was established by Berko (1958). Bybee and Slobin's contribution, then, was to identify the schema as the missing link between amalgams and categorical rules. We will consider this schema more closely in a moment, but first consider stage c., the categorical rule. Notice that to learn rule (1), the child must figure out that regular verbs can be divided into two mutually exclusive categories: (1) a category that ends in an alveolar stop; and (2) a category that ends in any other sound. There is no overlap between these two categories of regular verbs. Each has defining features. The defining features of the category which takes the long past morpheme are shown to the right of the slash mark in part a. of rule (1). The child's task, then, is to isolate these defining features. Bybee and Slobin hypothesize that before these features are isolated, the child forms a schema or mental representation of the past tense of regular verbs based on their surface phonological similarity: the fact that all regular past tense verb forms end in an alveolar stop, voiced or voiceless. Bybee and Slobin (1982:267) write this schema as either (3a) or (3b).

(3a) A past tense verb ends in /t/ or /d/.

(3b) ... /t/
/d/
$\begin{bmatrix} \text{verb} \\ \text{past} \end{bmatrix}$

In a subsequent experimental study of the acquisition of the past tense of irregular verbs, Bybee and Moder (1983) found that the schema

abstracted from amalgams in stage b. may have a more complicated structure than in (3). Bybee and Moder studied the category of irregular verbs (class II verbs) whose past tense has the vowel /ʌ/ and which usually end in a velar or nasal. Examples include stung and dug. Their experiment worked like this: subjects were rapidly read a list of nonsense words which included words resembling class II verbs, such as strig. The subjects were asked to imagine that the nonsense words were verbs and to guess what their past tense forms might be. The subjects sometimes produced a regularized past tense form like strigged and sometimes a class II past tense form like strug. By varying the initial and final consonants of the cue words, Bybee and Moder were able to discover the phonological features of these words that were most likely to elicit the class II form. They hypothesize, then, that in learning the past tense of class II verbs, children pass through only stages a. and b. of (2). In stage a. the individual forms are learned by rote, and in stage b. these forms are associated by means of a schema based on their phonological similarity. This schema could be written in the form of a prototype or most typical example of class II verbs. Such a schema might have the form shown in (4).

(4) /s/ C (C) /ʌ/ C
[+nasal]
[+velar]

Bybee and Moder speculate that during their experiment, when the subjects were read a cue word like strig, they mentally constructed both a regular past tense form and an irregular class II past tense form. Then, they compared the irregular form to the prototype form. If the irregular form they had constructed was similar to the prototype, they uttered it; otherwise, they uttered the regular past tense form.

Bybee and Moder suggest that in learning the past tense of class II verbs, learners are unable to get to stage c. in (2), a rule which changes a base form into a past tense form, because there are no defining features for the base forms of these verbs. Thus, the prototype schema is the highest level of abstraction possible for this category of verbs.

Let us now consider more carefully the mental

category PAST TENSE OF CLASS II VERBS. Schema (4) represents a prototypical or central member of this category, but it does not tell all the information that Bybee and Moder discovered about the category; specifically, it does not tell how less central members of the category can diverge from the prototype. Thus, (4) does not state that a candidate for membership in the category must have /ʌ/, but need not have initial /s/ (though it would be nice). Nor does (4) tell us that a final velar consonant is nicer (that is, more central to the category) than a final nasal consonant. Bybee and Moder presented the information about how close divergent forms were to the prototype by means of tables, but this information can also be expressed using the notation developed by variationists -- namely, in the form of a weighted feature bundle or variable rule. In a replication of Bybee and Moder's experiment, Adamson (forthcoming) found that for his subjects the weighted feature bundle had the form shown in (5).

(5) PAST --> [CLASS 2]

$$\langle r\ /s/\rangle \quad C \quad (C) \quad \begin{matrix} V \\ [+central] \\ [+mid] \end{matrix} \quad \begin{matrix} C \\ \langle A[+velar] \\ B[+nasal] \rangle \end{matrix}$$

Rule (5) specifies the necessary (though not the sufficient) features and the optional features for the category PAST TENSE FORM OF A CLASS II VERBS. The necessary features are an inital consonant, a mid-central vowel, and a final consonant. The optional features are ranked in the order of their importance using the Greek letter notation used in variable rules. A past tense form with the alpha and gamma features present (such as <u>strug</u>) is closer to the prototype than a form with the beta and gamma features present (such as <u>strum</u>). The class II verb schema can thus be written using the weighted feature bundle of variable rule notation. This fact suggests that variationist tools and methods of analysis can be useful to language acquisition scholars. Below we will review an important study done using these tools, but first consider in more detail the theory of prototype categories we have just encountered.

Prototype theory has become perhaps the dominant

theory of human categorization within psychology. It's chief theoretician is the psychologist Eleanor Rosch, who proposed the theory as an alternative to the classical theory of categories, which dates from Aristotle. A good example of an Aristotlian category is the category of regular verbs which take the long past tense morpheme shown in part a. of rule (1). This category consists of all the regular verbs whose final segment has the features [-sonorant], [+alveolar], and [-palatal]. According to the classical theory, the members any conceptual category such as BIRD or CUP, similarly share essential or defining features. Artisotle identified the defining features of HUMAN BEING as [+biped], and [-feathers]. Rosch (1975, 1978), following Wittgenstein (1953) proposed an alternative to the classical theory. She claimed that members of the same conceptual category do not have to have any features in common. Rather, the members of the category need only have some of the features of a central or prototypical member. Rosch noted that this arrangement is like a family resemblence. For example, two sisters may have no features in common, but they may still be recognized as members of the same family because they each have different features of their mother, who would be the central or prototypical member. Two dissimilar sisters in the family PAST TENSE OF CLASS II VERBS are won and dug.

Rosch based her theory on a number of famous experiments which showed that the classical theory did not square with the facts of human categorization. The classical theory predicts that no member of a conceptual category will have a special cognitive status. If category membership depended only on possessing certain essential features, all entities that possessed those features should be cognitively equal. However, Rosch found that people often consider some members of a category more typical, or central, than others. Thus, people consider robins and sparrows typical birds, but not chickens and penguins. In one experiment, Rosch asked her subjects to mark on a scale of one to seven how good an example of a category various members were. How good an example of BIRD is a chicken? Rosch found that her subjects' judgements of typicality correlated strongly. In another experiment, she asked subjects to press a button to indicate true or false in response to statements like "a penguin is a bird." She found that the subjects' reaction times were much faster for typical members of categories than for nontypical

members. This variation in people's reaction times, which reflects an uncertainty in judgement, is called a "prototype effect." Prototype effects can occur when people have to categorize an entity which varies from a prototypical member of that category. The variation between the regular past tense forms and class II past tense forms in Bybee and Moder's experiment is another example of a prototype effect. We will encounter prototype effects in grammaticality judgements below.

To summarize, Rosch's experimental results led her to conclude that conceptual categories like BIRD and PET are not mentally organized according to the principles of set theory, as in the classical account where all members of a category share essential features, but are organized around a prototypical member. Bybee and Moder claimed that morphological categories can be organized in this way as well. For example, in prototype schema (5), string is a central member of the category PAST TENSE OF CLASS II VERBS, but dug is a peripheral member.

We now consider a language acquisition study done within the variationist framework, which shows a pattern of acquisition similar to the three stages of (2). Labov and Labov (1978) studied their daughter Jessie's acquisition of subject-verb inversion in WH- questions. Using the VARB rule 2 computer program (Cedergren and Sankoff 1974) to analyze virtually all of Jessie's WH questions over a 30 month period, the Labovs found that the rule learning process included the three stages shown in (6).

(6) a. Formulaic patterns
b. A variable rule
c. A categorical rule

In stage a., Jessie produced both uninverted and apparently inverted forms, as in (7) and (8).

(7) Where this comes from?
(8) Where's Philadelphia?

The Labovs found that forms like (8), however, were not usually true cases of inversion, since the "inverted verb" was only the sound /s/, not the full form is, or any other auxiliary verb. This conclusion was reached by using the VARB rule program to analyze the effect of the presence of the phoneme /s/ following the WH word, on inverted word order.

During the initial stage the presence of /s/ strongly favored inverted word order, but during the later stages it did not. Since in adult speech the rule for contraction must follow the rule for inversion, the only way to account for the early favoring effect of /s/, that is for apparent contraction, is to assume that it was an optional part of unrelated phrase structure rules like (9) and (10).

(9) S[WHERE] --> where (s) + NP
"Where's Philadelphia?"
(10) S[WHAT] --> What (s) + NP
"What's that?

These semi-productive phrase structure rules are analogous to the amalgams postulated for stage a. by Bybee and Slobin.

Stage c., the final stage, of Jessie's WH rule learning was the adult categorical rule (11).
(11)
Q[WH] -->
WH-WORD - Tense - AUX - (NEG) - NP - X

Rule (11) reflects the fact that when the first word in a sentence was a member of the grammatical category WH-WORD, Jessie always used inverted order. Before turning to the variable rule in stage b., let us consider the nature of the grammatical category WH WORD, a consideration that will take us back to the theory of prototypes.

Lakoff (1987) has built on Rosch's prototype theory to propose that many linguistic categories are a kind of prototype category called a "radial category." The members of radial categories resemble a central member of the category, as in the prototype category PAST TENSE OF CLASS 2 VERBS represented in (4). However, radial categories cannot be represented by a weighted feature bundle. An example of a radial category is the lexical item over. According to Lakoff, a central meaning of over is ABOVE, or ON TOP OF, as in (12).

(12) Sam walks over the hill everyday.
Given this meaning of over, it is impossible to predict the meaning of over in (13).

(13) Sam lives over the hill.
Traditional accounts of the semantics of over have simply said that there are two different lexical items which are unrelated homonyms. But Lakoff claims

that although the meaning of over in (13) must be learned separately from the meaning in (12), it makes sense that the meaning in (13) should exist. That is, the meaning in (13) is motivated. The motivation, in this case, is our knowledge of the world that in order to get from where the speaker is to where Sam lives, it is necessary to go over the hill in the sense of (12).

Having introduced the term radial category, we return to Jessie's acquisition of rule (11). Using the VARB Rule program to examine the effect of various sentence constituents on Jessie's rate of inversion, the Labovs found that the most important constraint was the particular WH word with which the question began. This information can be represented by means of a rule like (14).

(14) Q[WH] --→
WH-WORD - Tense - AUX - (NEG) - NP - X

⟨ how
where
what
when ⟩

Rule (14) says that Jessie was most likely to use inverted word order after how, next after a where, and so on.

The Labovs suggest that the ordering of the WH word constraints in (14) reflects the degree to which the the constituents these words question are integreated into a proposition. Thus, a direct object is most tightly integrated into a verb phrase; next the locative, next the adverb of manner, and then the adverb of time, a hypothesis supported by Ross (1982). This relative degree of integration is reflected in the ordering of these constituents in a sentence like: He took the train downtown in a hurry last Wednesday. Of course this order of integration into a proposition (what, where, how, when) does not exactly match the order of the constraints in (14) (which is how, where, what, when). The Labovs explain this discrepency by noting that where and what operated at roughly the same frequency, and how was produced, at the outset, by a phrase structure rule that was different than the others (which we shall discuss in a moment). There are two possible problems with the Labovs' account.[1] First, as noted above, the constraint ordering in (14) only roughly matches the

degree of the corresponding constituents' integration into a sentence. Second, it is not clear why inverted word order should be more frequent when tightly integrated constituents, such as direct object, are sentence initial. To acquire WH questions, Jessie had to learn two deviations from canonical word order: The AUX-subject order and the initial WH word. It would seem more rather than less difficult to learn the second deviation when the WH word corresponds to a tightly integrated sentence constituent.

I would like to suggest an alternative hypothesis for the constraint ordering in (14), in which the variation in inverted and uninverted word order is a prototype effect associated with the radial category WH WORD. As we have seen, to acquire a categorical rule for inverted word order, Jessie had to construct the grammatical category WH WORD, which is the first element to the left of the arrow in rule (11). An intermediate step in this construction could have been a radial category, which is represented by the bracketed element in rule (14). The ordering of the WH word constraints in (14) would reflect the degree to which these words are central to the radial category. According to this hypothesis, Jessie's task was to isolate the defining feature of the environment in which to use inverted word order, namely the presence of the category WH WORD at the beginning of the question. The bracketed element in rule (14) represents the partial construction of this category.

Evidence for the radial category hypothesis is the fact that the order of the WH word constraints in (14) exactly matches the order in which the phrase structure rules containing these words appeared in Jessie's speech, suggesting that the radial category WH WORD was built up around <u>how</u>, the first WH word Jessie used. Further evidence is provided by tracing the development of <u>how</u> questions in Jessie's speech. The Labovs note that Jessie's first WH questions involved <u>how</u> in frozen expressions such as (15), which were produced by a phrase structure rule like 16).

(15) How 'bout you move?

(16) Q[HOW] --> <u>how</u> + V1 + NP + (VP)

In rule (16) V1 is a class of words that originally included only <u>'bout</u>, but came to include <u>come</u> and <u>do</u>. The Labovs observe, "It was natural for this <u>do</u> to

develop the alternations of tense and number characteristic of the tense marker" (p.28). This development would have resulted in a rule such as (17), which is only one step away from a fully productive rule for how questions such as (18).

(17) Q[HOW] -> how + tense + do + NP + X

(18) Q[HOW] -> how + tense + AUX + NP + X

Perhaps Jessie reanalyzed phrase structure rules such as (9) and (10) on analogy with (17) and (18). "On analogy with" means that Jessie realized that how, where, what, and when were members of the same grammatical category WH WORD, and therefore could participate in a pattern like (18). This expanded pattern is the variable rule (14), which contains the radial category WH WORD in which how is the central member. Another way to state this hypothesis is to say that how questions led the development from amalgams to catagorical rule, and that the other WH questions followed this development because their initial element was analyzed as similar to how.

As we have seen, this proposed process of syntactic rule construction, which goes from amalgams to a variable rule containing a prototype category to a categorical rule is similar to the process of morphological rule construction proposed by Bybee and Slobin (1982). In addition, the process is similar to that by which lexical meanings are learned. For example, Bowerman (1977), claims that the initial meanings of lexical items cluster around a prototype which is generally the first referent for which the word is used.

On what basis might Jessie group together the individual WH words into the abstract category WH WORD? Recall that membership in the prototype category PAST TENSE OF CLASS 2 VERBS was based on phonological similarity. The WH words share several different kinds of similarity. First of all, as Maratsos and Chalkley (1980) point out, members of a syntactic category have similar privileges of occurrence. Thus, WH words not only occur in the same position in simple WH questions, they also occur in the same position in embedded WH questions and in echo questions. On the semantic level, as we have seen, all the WH words question a basic notion associated with a proposition. On the phonological

level, all the WH words are of one syllable and all begin, at least in many dialects, with the voiceless approximate /h/.

According to the radial category hypothesis suggested here, the cognitive explanation for Jessie's variation in WH questions during stage b. is similar to the explanation for Rosch's subjects' variation in identifying category members. Recall that Rosch's subjects more quickly answered true to statements like "A robin is a bird" than to statements like, "A penguin is a bird." According to Rosch, this difference in reaction time occurred because a robin is a more central member of the category BIRD and therefore more mentally accessible. Similarly, to apply rule (14), perhaps Jessie had to decide whether a particular sentence initial word was a member of the WH WORD category. For central members, this decision was more easily made, and so the rule was more frequently applied.

In conclusion, the Labovs' study demonstrates that important insights into the process of language acquisition can be gained through the longitudinal study of variation in child language. As the Labovs note, this approach to language acquisition scholarship contrasts with the approach pursued by Chomsky (recently restated in Chomsky 1986) which adopts the idealization that language acquisition is instantaneous, and thereby abstracts away from variation. The variationist approach is more compatible with the approach of cognitive psychologists such as Brown, Rosch, and Slobin who base their theories on naturalistic and experimental data. The radial category hypothesis proposed here is also compatible with cognitive psychologists' explanations for variation in child language since the hypothesis claims that variation can be a prototype effect resulting from the prototype nature of a partially constructed grammatical category.

FOOTNOTE

1. In support of their explanation for the ordering of constraints according to the degree of integration into a proposition, the Labovs point to the behavior of <u>why</u>. <u>Why</u> questions the constituent least integrated into a proposition, and during the time rule (14) was operating, Jessie practically never used inverted word order after <u>why</u> in spontaneous

speech. However, this extreme difference in rate of inversion between why and other WH words argues that why was governed by a separate rule. Furthermore, why was the only WH word sensitive to contextual style. In a formal elicitation context called the "question game," in which Jessie and her parents would take turns making up WH questions, Jessie almost always used inverted word order after why. Thus, variation in word order after why was almost totally governed by speaking style. Since this is the case, it is unclear why cognitive considerations, such as degree of integration into a proposition need be appealed to. It seems simpler to say that word order after why was governed by a separate rule which was sensitive to audience considerations.

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